

AMENDMENTS TO THE CLAIMS:

The following listing of claims supersedes all prior versions and listings of claims in this application:

1-2. (Cancelled)

3. (Currently Amended) A distributed computer system ~~according to claim 1~~

comprising:

a plurality of computers, each storing data items, each data item being assigned to one of a plurality of virtual directories;

each computer that has a said data item stored thereon having at least one node of a virtual network for directory look-up, said node for directory look-up comprising

(i) data identifying that one of the plurality of virtual directories with which the node for directory look-up is associated,

(ii) linking data comprising addresses of other such nodes for directory look-up, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the virtual directories forwarding the message to another node for directory look-up of the network, and

(b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated, generating a reply message identifying a computer that the node for directory look-up is located on:

each computer that has a said data item stored thereon having, for each item stored thereon, a node of a virtual network for item look-up, said node for item look-up comprising

(i) data identifying the item with which the node for item look-up is associated,

(ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item look-up, each of which networks corresponds to a respective different virtual directory, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the items, forwarding the message to another node for item look-up of the network, and

(b) in response to an enquiry message that identifies the item with which the node for item look-up is associated, generating a reply message including the identified item; and
wherein at least one computer has retrieval means responsive to receipt of a query identifying a directory and an item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory,

(ii) upon receipt of a reply message thereto, to send to the computer identified in the reply message an enquiry message identifying the item, and

(iii) to receive the reply message containing the item,

in which each computer having retrieval means includes also secondary retrieval means operable

(a) upon receipt of a reply message identifying a computer having one or more items in a particular directory to identify further computers having one or more items in that directory; and

(b) to create a list of items in that directory.

4. (Previously Presented) A computer system according to claim 3, wherein each computer that has a said data item stored thereon also has at least one node of a secondary virtual network for directory look-up, such that said nodes of a secondary

virtual network for directly look-up together form a respective secondary virtual network for each virtual directory, wherein said node of a secondary virtual network for directly look-up comprising a data storage area for containing a list of addresses of other nodes of the secondary virtual network that have items in the same directory and said node of a secondary virtual network for directly look-up is responsive to enquiry messages to return a message containing the addresses of the list; and

wherein the secondary retrieval means is operable, for identifying further computers having one or more items in the directory in question, to send an enquiry message to the node identified by the reply message and upon receipt of a response to iteratively send enquiry messages to addresses contained in the response to that enquiry message or in a response to a subsequent enquiry message.

5. (Currently Amended) A distributed computer system ~~according to claim 1,~~
comprising:

a plurality of computers, each storing data items, each data item being assigned to one of a plurality of virtual directories;

each computer that has a said data item stored thereon having at least one node of a virtual network for directory look-up, said node for directory look-up comprising

(i) data identifying that one of the plurality of virtual directories with which the node for directory look-up is associated,

(ii) linking data comprising addresses of other such nodes for directory look-up, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the virtual directories forwarding the message to another node for directory look-up of the network, and

(b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated, generating a reply message identifying a computer that the node for directory look-up is located on;

each computer that has a said data item stored thereon having, for each item stored thereon, a node of a virtual network for item look-up, said node for item look-up comprising

(i) data identifying the item with which the node for item look-up is associated,

(ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item look-up, each of which networks corresponds to a respective different virtual directory, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the items, forwarding the message to another node for item look-up of the network, and

(b) in response to an enquiry message that identifies the item with which the node for item look-up is associated, generating a reply message including the identified item; and

wherein at least one computer has retrieval means responsive to receipt of a query identifying a directory and an item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory,

(ii) upon receipt of a reply message thereto, to send to the computer identified in the reply message an enquiry message identifying the item, and

(iii) to receive the reply message containing the item,

wherein some of said directories are assigned, as subdirectories, to another of said directories and wherein each computer having retrieval means also includes:

(a) first subdirectory retrieval means responsive to input of a directory name to identify a ~~computing node~~ computer having items in at least one subdirectory assigned to that directory; and

(b) second subdirectory retrieval means connected to receive an address identified by the first subdirectory retrieval means and operable in response thereto to identify further ~~computing nodes~~ computers having items in at least one subdirectory assigned to the same directory.

6-7. (Cancelled)

8. (Currently Amended) A computer ~~according to claim 6~~ for use in a distributed computer system comprising a plurality of computers, said computer comprising:

a data store which stores data items, each data item being assigned to one of a plurality of virtual directories;

at least one node of a virtual network for directory look-up, said node for directory look-up comprising

(i) data identifying that one of the plurality of virtual directories with which the node for directory look-up is associated,

(ii) linking data comprising addresses of other such nodes for directory look-up, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the virtual directories, forwarding the message to another node for directory look-up of the network, and

(b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated, generating a reply message identifying the computer that the node for directory look-up is located on;

for each item stored on said computer, a node of a virtual network for item look-up, said node for item look-up comprising

(i) data identifying the item with which the node for item look-up is associated,

(ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item look-up, each of which networks corresponds to a respective different virtual directory, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the items, forwarding the message to another node for item look-up of the network, and

(b) in response to an enquiry message that identifies the item with which the node for item look-up is associated, generating a reply message including the item; and
retrieval means responsive to receipt of a query identifying a directory and an item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory,

(ii) upon receipt of a reply message thereto, to send to a computer identified in the reply message an enquiry message identifying the item, and

(iii) to receive the reply message containing the item,

including also secondary retrieval means operable:

(a) upon receipt of a reply message identifying a computer having one or more items in a particular directory to identify further computers having one or more items in that directory; and

(b) to create a list of items in that directory.

9. (Currently Amended) A computer ~~according to claim 6,~~ for use in a distributed computer system comprising a plurality of computers, said computer comprising:
a data store which stores data items, each data item being assigned to one of a plurality of virtual directories;

at least one node of a virtual network for directory look-up, said node for directory look-up comprising

(i) data identifying that one of the plurality of virtual directories with which the node for directory look-up is associated,

(ii) linking data comprising addresses of other such nodes for directory look-up, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the virtual directories, forwarding the message to another node for directory look-up of the network, and

(b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated, generating a reply message identifying the computer that the node for directory look-up is located on;

for each item stored on said computer, a node of a virtual network for item look-up, said node for item look-up comprising

(i) data identifying the item with which the node for item look-up is associated,

(ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby

said linking data together define a plurality of virtual networks for item look-up,
each of which networks corresponds to a respective different virtual directory,
and

(iii) software operable

(a) in response to an enquiry message that identifies another of the
items, forwarding the message to another node for item look-up of the
network, and

(b) in response to an enquiry message that identifies the item with
which the node for item look-up is associated, generating a reply message
including the item; and

retrieval means responsive to receipt of a query identifying a directory and an
item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry
message identifying the directory,

(ii) upon receipt of a reply message thereto, to send to a computer
identified in the reply message an enquiry message identifying the item, and

(iii) to receive the reply message containing the item,

wherein some of said directories are assigned, as subdirectories, to another of
said directories and wherein the computer also includes:

(i) first subdirectory retrieval means responsive to input of a directory name to identify a ~~computing node~~ computer having items in at least one subdirectory assigned to that directory; and

(ii) second subdirectory retrieval means connected to receive an address identified by the first subdirectory retrieval means and operable in response thereto to identify further ~~computing nodes~~ computers having items in at least one subdirectory assigned to the same directory.

10. (Original) A computer according to claim 9 in which the retrieval means is operable to compile a composite list of said subdirectories.

11. (Cancelled)

12. (Currently Amended) A distributed computer system according to claim [[11]] 16 in which the retrieval means is operable to retrieve from each of said identified plurality of ~~computing nodes~~ computers a list of items stored thereon, and to compile a composite list of said items.

13. (Cancelled)

14. (Currently Amended) A distributed computer system according to claim [[13]] 26 in which the retrieval means is operable to compile a composite list of said subdirectories.

15. (Currently Amended) A distributed computer system according to claim [[11]] 16 wherein some of said directories are assigned, as subdirectories, to another of said directories and wherein each computer having retrieval means also includes:

first subdirectory retrieval means responsive to input of a directory name to identify a ~~computing node~~ computer having items in at least one subdirectory assigned to ~~that~~ the directory whose name is input; and

second subdirectory retrieval means connected to receive an address identified by the first subdirectory retrieval means and operable in response thereto to identify further ~~computing nodes~~ computers having items in at least one subdirectory assigned to the ~~same~~ directory whose name is input.

16. (Currently Amended) A distributed computer system ~~according to claim 11~~ wherein comprising:

a plurality of computers, wherein each computer stores data items, each data item being assigned to one of a plurality of virtual directories;

first retrieval means responsive to input of a directory name to identify a computer having items in the directory whose name is input;

second retrieval means connected to receive an address identified by the first retrieval means and operable in response thereto to identify further computer having items in the directory whose name is input;

wherein each computer having items in a given directory has associated with it a data storage area for containing addresses for other computers having items in the same directory and is responsive to enquiry messages to return a message containing the addresses of the list; and

wherein the second retrieval means is operable to send an enquiry message to the computer identified by the first retrieval means and upon receipt of a response to iteratively send enquiry messages to addresses contained in the response to that enquiry message or in a response to a subsequent enquiry message, thereby identifying a plurality of computers having items in the directory in question,

wherein the first retrieval means is formed by a primary network of virtual nodes, each node being defined by a list of links to other nodes of the ~~secondary~~ primary network, each ~~entry~~ link in the list including a label and address of [[the]] a respective other node; and

each node includes (i) means responsive to receipt of a request message containing a label to propagate the request message within the network, and (ii) means

responsive to receipt of a request message containing a label matching the label of the node receiving it to generate a reply message.

17. (Currently Amended) A distributed computer system ~~according to claim 11~~ comprising a plurality of computing nodes, wherein each computer stores data items, each data item being assigned to one of a plurality of virtual directories;

first retrieval means responsive to input of a directory name to identify a computing node having items in that directory;

second retrieval means connected to receive an address identified by the first retrieval means and operable in response thereto to identify further computing nodes having items in the same directory;

wherein each computing node having items in a given directory has associated with it a data storage area for containing addresses for other computing nodes having items in the same directory and is responsive to enquiry messages to return a message containing the addresses of the list; and

wherein the second retrieval means is operable to send an enquiry message to the node identified by the first retrieval means and upon receipt of a response to iteratively send enquiry messages to addresses contained in the response to that enquiry message or in a response to a subsequent enquiry message, thereby identifying a plurality of computing nodes having items in the directory in question,

in which the second retrieval means is formed by a secondary network of virtual nodes, each node being defined by a list of links to other nodes of the primary secondary network, each ~~entry~~ link in the list including an address of ~~[[the]]~~ a respective other node; and wherein each node includes means responsive to receipt of a request message to generate a reply message containing the addresses of the list.

18. (Currently Amended) A distributed computer system according to claim 16 in which the second retrieval means is formed by a secondary network of virtual nodes, each node being defined by a list of links to other nodes of the primary secondary network, each ~~entry~~ link in the list including an address of ~~[[the]]~~ a respective other node; and wherein each node includes means responsive to receipt of a request message to generate a reply message containing the addresses of the list; and

in which the reply message generated by a node of the primary network includes the address of that node of the secondary network which is associated with the node generating the reply message.

19. (Previously Presented) A distributed computer system according to claim 16, wherein

the second retrieval means is formed by a secondary network of virtual nodes, each node being defined by a list of links to other nodes of the primary network, each

entry in the list including an address of the respective other node; and wherein each node includes means responsive to receipt of a request message to generate a reply message containing the addresses of the list;

each node of the primary network includes means operable to initiate and to propagate exploratory messages each containing the label and address of the initiating node of the primary network; and

each node is operable upon receipt of an exploratory message containing a label matching that of the receiving node and an address not matching that of the receiving node to generate a notification message for addition of a link to the secondary network, said notification message identifying the node initiating the exploratory message and containing the address of the node of the secondary network associated with the receiving node.

20. (Previously Presented) A distributed computer system according to claim 19, in which the notification message contains, as destination, the address of the initiating node, and the initiating node is operable upon receipt thereof to forward to the node of the secondary network associated with the initiating node a message requesting addition of a link between it and the node having the address contained in the notification message.

21. (Previously Presented) A distributed computer system according to claim 17 in which each node of the secondary network includes processing means programmed to perform the following operations:

receiving messages;

responding to messages requesting information about the contents of the list;

complying with received requests to remove an address from the list and insertion of another address into the list; and

in response to receipt of a message requesting a link between the node and a second node:

(A) generating a message to the second node requesting information about the contents of its list;

(B) determining whether both the first node and second node has in each case a number of addresses in its list which is less than the predetermined number;

(C) in the event that this condition is satisfied, inserting into its list the address of the second node and generating a message to the second node requesting the second node to add to its list the address of the node;

(D) in the event that this condition is not satisfied, determining whether the node has a number of addresses in its list which is at least two less than the predetermined number, and if so

(a) selecting from the list of the second node the address of a third node;

(b) inserting the address of the second node into the list of the first node and inserting the address of the third node into the list of the first node;

(c) generating a message to the second node requesting the removal of the address of the third node from the list of the second node and insertion of the address of the node; and

(d) generating a message to the third node requesting the removal of the address of the second node from the list of the third node and insertion of the address of the node.

22. (New) A distributed computer system, said system comprising:
- a plurality of computers, each storing data items, each data item being assigned to one of a plurality of virtual directories;
- each computer that has a said data item stored thereon having at least one node of a virtual network for directory look-up, said node for directory look-up comprising
- (i) data identifying that one of a plurality of the virtual directories with which the node for directory look-up is associated,

(ii) linking data comprising addresses of other such nodes for directory look-up, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the virtual directories forwarding the message to another node for directory look-up of the network, and

(b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated, generating a reply message identifying a computer that the node for directory look-up is located on, each computer that has a said data item stored thereon having, for each item stored thereon, a node of a virtual network for item look-up said node for item look-up comprising

(i) data identifying the item with which the node for item look-up is associated,

(ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item look-up, each of which networks corresponds to a respective different virtual directory, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the items forwarding the message to another node for item look-up of the network,

(b) in response to an enquiry message that identifies the item with which the node for item look-up is associated, generating a reply message identifying the computer that the node for item look-up is located on, and

(c) in response to a request message that identifies the item with which the node for item look-up is associated, generating a reply message including the item, and

wherein at least one computer has retrieval means responsive to receipt of a query identifying a directory and an item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory,

(ii) upon receipt of a reply message thereto, to send to the computer identified in the reply message an enquiry message identifying the item, and

(iii) upon receipt of a reply message thereto, to send to the computer identified in the reply message a message requesting the item,

in which each computer having retrieval means includes also secondary retrieval means operable

- (a) upon receipt of a reply message identifying a computer having one or more items in a particular directory to identify further computers having one or more items in that directory, and
- (b) to create a list of items in that directory.

23. (New) A distributed computer system, said system comprising:
- a plurality of computers, each storing data items, each data item being assigned to one of a plurality of virtual directories;
- each computer that has a said data item stored thereon having at least one node of a virtual network for directory look-up, said node for directory look-up comprising
- (i) data identifying that one of a plurality of the virtual directories with which the node for directory look-up is associated,
 - (ii) linking data comprising addresses of other such nodes for directory look-up, and
 - (iii) software operable
 - (a) in response to an enquiry message that identifies another of the virtual directories forwarding the message to another node for directory look-up of the network, and
 - (b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated,

generating a reply message identifying a computer that the node for directory look-up is located on;

each computer that has a said data item stored thereon having, for each item stored thereon, a node of a virtual network for item look-up, said node for item look-up comprising

(i) data identifying the item with which the node for item look-up is associated,

(ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item look-up, each of which networks corresponds to a respective different virtual directory, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the items, forwarding the message to another node for item look-up of the network,

(b) in response to an enquiry message that identifies the item with which the node for item look-up is associated, generating a reply message identifying a computer that the node for item look-up is located on; and

(c) in response to a request message that identifies the item with which the node for item look-up is associated, generating a reply message including the item; and

wherein at least one computer has retrieved means responsive to receipt of a query identifying a directory and an item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory,

(ii) upon receipt of a reply message thereto, to send to the computer identified in the reply message an enquiry message identifying the item, and

(iii) upon receipt of a reply message thereto, to send to the computer identified in the reply message a message requesting the item,

wherein some of said directories are assigned, as subdirectories, to another of said directories and wherein each computer having retrieval means also includes:

(a) first subdirectory retrieval means responsive to input of a directory name to identify a computer having items in at least one subdirectory assigned to that directory; and

(b) second subdirectory retrieval means connected to receive an address identified by the first subdirectory retrieval means and operable in response thereto to identify further computers having items in at least one subdirectory assigned to the same directory.

24. (New) A computer for use in a distributed computer system comprising a plurality of computers, said computer comprising:

a data store which stores data items, each data item being assigned to one of a plurality of virtual directories;

at least one node of a virtual network for directory look-up, said node for directory look-up comprising:

- (i) data identifying that one of a plurality of the virtual directories with which the node for directory look-up is associated,
- (ii) linking data comprising addresses of other such nodes for directory look-up, and
- (iii) software operable
 - (a) in response to an enquiry message that identifies another of the virtual directories forwarding the message to another node for directory look-up of the network, and
 - (b) in response to an enquiry message that identifies the virtual with which the node for directory look-up is associated generating a reply message identifying the computer the node for directory look-up is located on;

for each item stored on said computer, a node of a virtual network for item look-up, said node for item look-up comprising

- (i) data identifying the item with which the node for item look-up is associated,
- (ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item look-up, each of which networks corresponds to a respective different virtual directory, and
- (iii) software operable
 - (a) in response to an enquiry message that identifies another of the items forwarding the message to another node for item look-up of the network,
 - (b) in response to an enquiry message that identifies the item with which the node for item look-up is associated generating a reply message identifying the computer the node for item look-up is located on, and
 - (c) in response to an request message identifying the item with which the node for item look-up is associated generating a reply message including the item; and

retrieval means responsive to receipt of a query identifying a directory and an item within that directory to

- (i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory;
 - (ii) upon receipt of a reply message thereto, to send to a computer identified in the reply message an enquiry message identifying the item;
 - (iii) upon receipt of a reply message thereto, to send to the computer identified in the reply message a message requesting the item,
- including also second retrieval means operable
- (a) upon receipt of a reply message identifying a computer having one or more items in a particular directory to identify further computers having one or more items in that directory; and
 - (b) to create a list of items in that directory.

25. (New) A computer for use in a distributed computer system comprising a plurality of computers, said computer comprising:

a data store which stores data items, each data item being assigned to one of a plurality of virtual directories;

at least one node of a virtual network for directory look-up, said node for directory look-up comprising

- (i) data identifying that one of a plurality of the virtual directories with which the node for directory look-up is associated,
- (ii) linking data comprising addresses of other such nodes for directory look-up; and
- (iii) software operable
 - (a) in response to an enquiry message that identifies another of the virtual directories forwarding the message to another node for directory look-up of the network, and
 - (b) in response to an enquiry message that identifies the virtual directory with which the node for directory look-up is associated generating a reply message identifying the computer the node for directory look-up is located on;

for each item stored on said computer, a node of a virtual network for item look-up, said node for item look-up comprising

- (i) data identifying the item with which the node for item look-up is associated,
- (ii) linking data comprising addresses of other such nodes for item look-up each associated with an item assigned to the same virtual directory, whereby said linking data together define a plurality of virtual networks for item

look-up, each of which networks corresponds to a respective different virtual directory, and

(iii) software operable

(a) in response to an enquiry message that identifies another of the items forwarding the message to another node for item look-up of the network,

(b) in response to an enquiry message that identifies the item with which the node for item look-up is associated generating a reply message identifying the computer the node for item look-up is located on, and

(c) in response to an request message identifying the item with which the node for item look-up is associated generating a reply message including the item; and

retrieval means responsive to receipt of a query identifying a directory and an item within that directory to

(i) send to a node of the virtual network for directory look-up an enquiry message identifying the directory;

(ii) upon receipt of a reply message thereto, to send to a computer identified in the reply message an enquiry message identifying the item;

(iii) upon receipt of a reply message thereto, to send to the computer identified in the reply message a message requesting the item, wherein some of said directories are assigned as subdirectories, to another of said directories and wherein the computer also includes:

(i) first subdirectory retrieval means responsive to input of a directory name to identify a computer having items in at least one subdirectory assigned to that directory; and

(ii) second subdirectory retrieval means connected to receive an address identified by the subdirectory retrieval means and operable in response thereto to identify further computers having items in at least one subdirectory assigned to the same directory.

26. (New) A distributed computer system comprising:

a plurality of computers, wherein each computer stores data items, each data item being assigned to one of a plurality of virtual directories, some of said directories being assigned, as subdirectories, to another of said directories;

first retrieval means responsive to input of a directory name to identify a computer having items in at least one subdirectory assigned to the directory whose name is input;

second retrieval means connected to receive an address identified by the first retrieval means and operable in response thereto to identify further computers having items in at least one subdirectory assigned to the directory whose name is input;

wherein each computer having items in at least one subdirectory assigned to a given directory has associated with it a data storage area for containing a list of addresses for other computers having items in at least one subdirectory assigned to the same directory and is responsive to enquiry messages to return a message containing the addresses of the list;

wherein the second retrieval means is operable to send an enquiry message to the computer identified by the first retrieval means and upon receipt of a response to iteratively send enquiry messages to addresses contained in the response to the enquiry message or in a response to a subsequent enquiry message, thereby identifying a plurality of computers having items in subdirectories of the directory in question; and

wherein the first retrieval means is formed by a primary network of virtual nodes, each node being defined by a list of links to other nodes of the primary network, each link in the list including a label and address of a respective other node; and

each node includes (i) means responsive to receipt of a request message containing a label to propagate the request message within the network, and (ii) means

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responsive to receipt of a request message containing a label matching the label of the node receiving it to generate a reply message.